

CECW-ET

**DEPARTMENT OF THE ARMY
U.S. Army Corps of Engineers
Washington, DC 20314-1000**

EM 1110-2-501

Manual
No. 1110-2-501

1 February 1999

**Design, Construction, and Operation
SMALL WASTEWATER SYSTEMS**

Table of Contents

Subject	Paragraph	Page
Chapter 1		
Introduction		
Purpose	1-1	1-1
Applicability	1-2	1-1
References	1-3	1-1
Distribution Statement	1-4	1-1
Laws and Regulations	1-5	1-1
Chapter 2		
Preliminary Data Requirements		
General	2-1	2-1
Recreational Facilities	2-2	2-1
Determination of Effluent Limitations	2-3	2-1
Site Selection Factors	2-4	2-2
Chapter 3		
Wastewater Generation and Characterization		
General	3-1	3-1
Visitation and Length of Stay	3-2	3-1
Variations in Visitation	3-3	3-1
Water Usage and Wastewater Generation	3-4	3-1
Monthly and Daily Flow Distribution	3-5	3-2
Wastewater Characterization	3-6	3-3
Chapter 4		
Collection Systems		
General	4-1	4-1
Absence of Pressurized Water Supply	4-2	4-1
Transport by Truck	4-3	4-1
Gravity Flow Systems	4-4	4-3
Force Main Systems	4-5	4-3
Alternative Wastewater Collection Systems	4-6	4-4

Subject	Paragraph	Page
Chapter 5		
Treatment Design Considerations		
General	5-1	5-1
Small Individual Units	5-2	5-1
Conventional Wastewater Treatment Facilities	5-3	5-4
Stabilization Ponds	5-4	5-10
Natural Systems for Wastewater Treatment	5-5	5-11
Man-Made Wetlands	5-6	5-19
Nutrient Removal	5-7	5-23
Sludge Treatment and Disposal	5-8	5-25
Disinfection of Wastewater Effluents	5-9	5-28
Chapter 6		
Laboratory Design, Sampling, and Flow Monitoring		
General	6-1	6-1
Laboratory Design	6-2	6-1
Sampling and Analysis	6-3	6-2
Flow Monitoring	6-4	6-2
Chapter 7		
Treatment Process Selection		
Overview	7-1	7-1
Site Visitation	7-2	7-1
Local Resources	7-3	7-1
Economic Considerations	7-4	7-1
Health Considerations	7-5	7-3
Aesthetic Considerations	7-6	7-4
Safety Considerations	7-7	7-4
Access/Security Considerations	7-8	7-4
Comparison of Treatment Processes	7-9	7-5
Chapter 8		
Design References and Examples		
General	8-1	8-1
Military Design Manuals	8-2	8-1
National Small Flows Clearinghouse (NSFC) Publications	8-3	8-2
Wastewater Design Manuals and Texts	8-4	8-2
U.S. Environmental Protection Agency (EPA)	8-5	8-2
Wastewater Design Criteria and Example Matrices	8-6	8-3
Additional Design Examples	8-7	8-4
Chapter 9		
General Wastewater System Design Deficiencies		
General	9-1	9-1
Overall Considerations	9-2	9-1
Conventional Design	9-3	9-5
Preliminary Unit Processes	9-4	9-6

Subject	Paragraph	Page
Primary Treatment Unit Process	9-5	9-10
Secondary Treatment Unit Processes	9-6	9-11
Sludge Dewatering	9-7	9-17
Non-Conventional Plants	9-8	9-17
Land Application	9-9	9-19
Sludge Drying and Disposal	9-10	9-20
Sewer Collection Systems	9-11	9-22
Lift Stations	9-12	9-22

Chapter 10

Sludge Disposal

General	10-1	10-1
Definitions	10-2	10-1
Management Standards	10-3	10-2
Toxic Metal Regulations	10-4	10-2
Effect of Land Application	10-5	10-2
Pathogen and Vector Attraction Reduction	10-6	10-2
Exclusions	10-7	10-3
Land Application Pollutant Limits	10-8	10-3
Land Application Management Practices	10-9	10-3
Surface Disposal Pollutant Limits	10-10	10-4
Pathogens and Vector Attraction Reduction	10-11	10-4
Pathogen Treatment Processes	10-12	10-5
Septage Applied to Agricultural Land, Forests, or Reclamation Sites	10-13	10-6
Wastewater Scum	10-14	10-6
Composting Methods	10-15	10-7
Composting Additives/Amendments/Bulking Agents	10-16	10-7
Equipment	10-17	10-7
Guidance	10-18	10-10

Appendix A

References

Appendix B

States with Regulations/Requirements Applicable to Small-Scale Wastewater Treatment Facilities

Appendix C

Wastewater Characterization Data

Appendix D

Wastewater Design Criteria and Examples Matrix Summary from Non-Military Sources

Appendix E

Design Examples

EM 1110-2-501

1 Feb 99

Appendix F

U.S. Army Experience with Natural Wastewater Treatment Systems

Appendix G

Abbreviations and Glossary of Terms